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Cruzando fronteiras: o caminho da fotomicrografia rumo ao reconhecimento artístico

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EDITOR'S NOTE

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1. Introduction

1 The connection between art and science through photomicrography is a promising field of study and a topic of interest to various authors. Although not referring to photomicrography, Benjamin was one of the pioneers in history of art to discuss the aesthetic appeal of photographic magnified images (Benjamin et al. 2008, 154). As for photomicrography, Sicard (2006) mentioned its qualities compared to scientific illustration in the nineteenth century and Frizot (1998), among others, alluded to the technical side of photomicrography in the history of photography. Gamwell (2003b, a) also wrote on the influence of microscopy in contemporary art with two brief but very insightful articles. Moreover, The Fruitbasket Gallery in Edinburg published a catalogue that accompanied an interesting exhibition of close-up images (Bradley, Ades and Baker 2009) and Kulper (2012) explored the aesthetics of photomicrographic images and discusses them as "two sides of the same epistemological coin" whilst Rob Kesseler authored and co-authored several books and articles, mostly regarding his artistic work in botanical photomicrography including in collaboration with scientists.

2 Many advances have been made in the study of photomicrography from the viewpoint of the history of science and photography. Furthermore, current practices confirm photomicrography as being a form of art and, for the most part, the result of the dialogue between art and science, leading us to another question: how did photomicrography come to be acknowledged as a form of art?

3 The aim of this paper is to provide a valid insight into the path of artistic recognition of photomicrography. Moreover, it aims to shed light into its contributions to the connection between art, nature and science. We investigated the records containing references to artistic and/or aesthetic features associated with photomicrography within *The Photographic Journal* of the Royal Photographic Society, which were complemented with additional information regarding contemporary practices of artistic photomicrography. Results show that the acknowledgement of photomicrography as a form of art amongst peers resulted from a gradual process, which knew noticeable advances from the 1930s onward. Furthermore, they show that contemporary practices in photomicrography are making important contributions to promote the dialogue between art, nature and science.

2. Methods

4 In order to construct a theoretical framework, we initially focused on a literature review regarding the interconnections between three core subjects: art, science and microscopy. We then proceeded to an initial analysis of documental sources. The main purpose was to explore the acknowledgment of photomicrography as art, over time, so as to construct the argument of our research. Data were collected predominantly in British photography periodicals. *The Photographic Journal*[1] (1853-), published by the Royal Photographic Society, was selected as main key source of information.[2] We explored a total of 153 volumes of this journal, ranging from 1853 to 2013. The choice for *The Photographic Journal* as main key source of information followed a combination of three main criteria. The first was its well-established reputation and credibility. The second was the fact that it is one of the world's pioneer journals of photography. The third criterion was the continuity of its publication ever since it was founded in 1853. This allowed for a consistent approach on the subject of photomicrography throughout an extended and continuous period of time within a major key source of information.

5 Firstly, we identified all references to photomicrography in *The Photographic Journal*.[3] Based on the resultant listing, we carried out a simple statistical analysis, so as to obtain a general perception of the presence of photomicrography among the subjects addressed by this journal. We filtered the references directly and indirectly[4] related to the artistic facet of photomicrography, organized them chronologically; and proceeded to analyse and interpret their content (text and images).

6 Throughout the research process, data gathered in *The Photographic Journal* were complemented with further information considered relevant for the subject. For the most part, we retrieved additional information from *The British Journal of Photography,* as well as books related to microscopy and photomicrography. Moreover, a review of more recent sources, namely published papers, books and information regarding photomicrography competitions, provided a valuable contribution for a more solid understanding of current approaches to photomicrography. They were especially relevant regarding contemporary

artistic practices of photomicrography, because they often convey the point of view of "artists-scientists" or "scientists-artists".[5] In fact, the importance of the photomicrographer's viewpoint (whether in science or in art) is transversal to the topic of this paper.

3. Results & discussion

3.1. The visible face of the invisible in the connection between art, science and microscopy

7 Previous studies reflect a broad consensus regarding the greatness and diversity of scientific achievements throughout the nineteenth century.[6] Scientific expeditions, debates and publications conveyed the latest advances of science to public knowledge.[7] Medicine, Geography, Zoology, Botany and the then-newly established modern sciences of Oceanography, Geology and Biology (Gamwell 2002, 83) brought new knowledge to the mind and conspicuously new aesthetic elements to the eye. As a result of these favourable circumstances, science was likely to have deepened its influence on other fields; especially on those based on creativity and imagination. In this context, art and science were brought together even closer than before[8], in a combination of scientific objectivity and aesthetic inspiration. A connection existing in scientific illustration, but also in fine and applied arts and in the emerging discipline we came to know as *design*.

8 By extending the spectrum of human vision into the "invisible", microscopy played a fundamental role in the reverence towards science, which characterized the nineteenth century.[9] A whole new world was opening up to the eyes of Humanity. A universe of shapes and patterns that celebrated the cellular structures of plants and animals; the morphology of branches, leaves and stylized flowers that suggested the movement of Nature's thriving life; and unheard-of living organisms discovered in the depths of the oceans.[10] Any previously familiar visual reality was now fused with unknown forms, transparencies, patterns, curves, colours, lines and light. A union so great that it became embedded in the minds of artists, laying the foundations for a new artistic vocabulary, primarily transposed to architecture and ornament[11], and expanding to an alliance of all the arts.

9 Several authors mention personalities such as the French glassmaker Emille Gallé or the Austrian painter Gustav Klimt, amongst many others of their time[12], as examples of artists who nourished a profound connection to science (Gamwell 2002; Thomas 2007, Maxmen 2010) and who expressed that connection through art. The search for those intertwined visions between art and science is a very interesting and quite fruitful task.

10 Figure 1 shows one of Gustav Klimt's most well known works, *The Kiss* (1907). The oval forms on the dress of the female figure clearly resemble cellular structures. Furthermore, they are disposed inside a circle-like area, as if seen through the lens of a microscope. This composition is reminiscent of early photomicrographs[13] that illustrated microscopic subjects in books and journals, in the early years of photomicrography. Klimt was a regular attendant at scientific lectures, where he contacted with microscopic images[14] (Maxmen 2010). Those images certainly caught his attention, because elements such as these are recurrent in his graphic vocabulary. Klimt's work is an interesting example of the connection between photomicrography and art. Yet, a major question still arises

pertaining to this subject. Was photomicrography an art itself? To address this matter we briefly recall the long-lasting discussion on whether *photography is* or *is not* considered art.

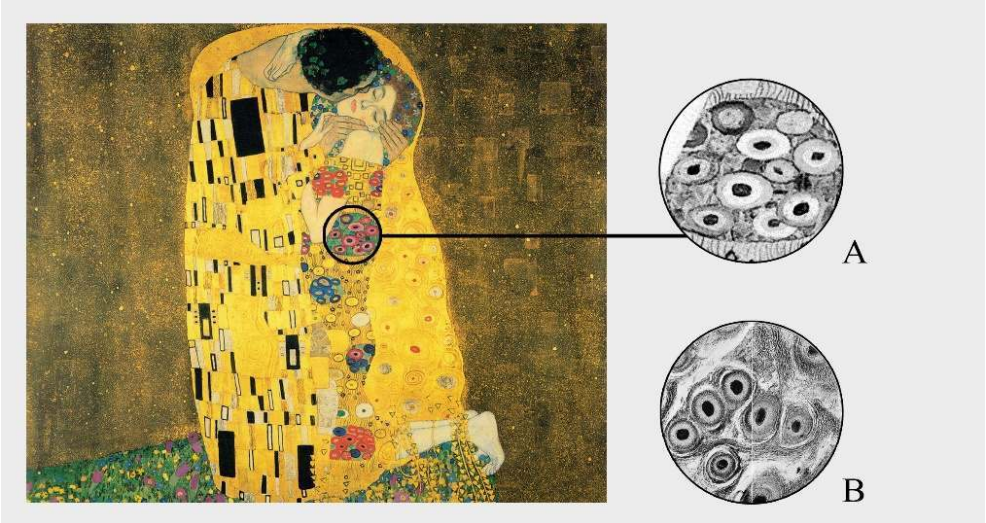


Fig. 1 – The Kiss, 1907, Gustav Klimt. Austrian Gallery Belveder. These particular shapes (A) resemble photomicrographs of human tissue as shown in the *Handbook of Photomicrography*, published in 1913 (B).

3.1.1. Beauty in science? The early years of photomicrography

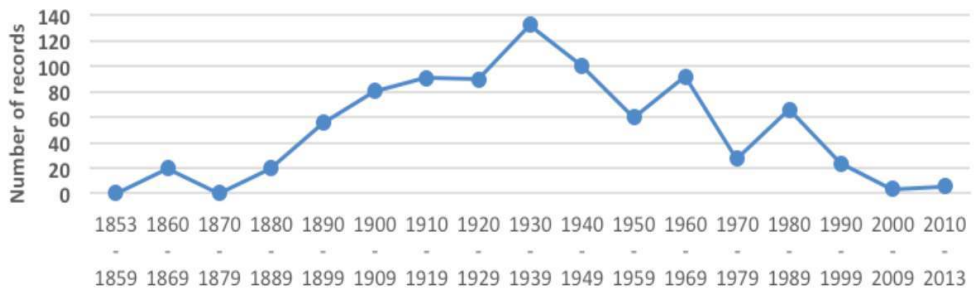
11 In his critique of the 1859 *Salon*, Baudelaire (1868, 261) described photography as the «most humble servant of sciences and arts». The writing of Baudelaire is one of many sources that allow us to understand the discussion about the existence of an artistic side to photography, in its early years.[15] We find there are two main issues in the centre of this debate, which also apply to photomicrography. First, photography was a mechanical process in which it was only possible to obtain an image through the use of the camera.[16] Secondly, a photograph was a truthful, hence objective, picture of reality.

12 This raised doubts in the minds of those most sceptical about the artistic worth of photography. Similar reservations were certainly directed to photomicrography, a then-fairly new and very particular branch of photography. Was it an expression of *beauty*? Was it a medium to convey scientific knowledge? *Was* it art? Was it *science*? Or, with the passage of time, could it be potentially both? We searched for answers in *The Photographic Journal* of the Royal Photographic Society (1853-).

3.2. Photomicrography within the scope of *The Photographic Journal* of the Royal Photographic Society

13 A search for the term "photomicrography", in the catalogue of *The Photographic Journal* (1853-) archive, retrieved 661 records. A second search for "micrography"[17], in the same archive, resulted in a total of 857 occurrences. Graph 1 illustrates the number and distribution of records retrieved by the search for the term "micrography" in *The Photographic Journal* between the years of 1853 and 2013.

Graph 1 – Number of records retrieved by the search for the term «micrography» in the online archive of *The Photographic Journal* of the Royal Photographic Society (1853-2013)



14 The first allusions to photomicrography in *The Photographic Journal* date back to 1864. The years between 1880 and 1939 registered a growing presence of photomicrography among the subjects addressed in the aforesaid journal, as opposed to a considerable decrease in the 1940s. This tendency was generally maintained throughout the second half of the twentieth century, with some increase in the decades of 1960 and 1980. As for the twenty first century, references to photomicrography are scarce comparing to the previous decades.

15 We find these figures important to assess the presence of photomicrography within the scope of *The Photographic Journal.* However, they resulted from a broad search and therefore do not provide sufficient elements for understanding the contexts of that presence; nor do they fulfil the requirements necessary to understand the process of artistic acknowledgment of photomicrography throughout time. A more insightful analysis of the respective texts and images was certainly necessary to address this subject. The results were significantly positive in regard to the recognition of an artistic side of photomicrography. It was a gradual process. We argue that its foundations lie on subtle comments regarding the aesthetic qualities of "beautiful slides of microscopic photographs" (Maddox 1864, 150), as those we first found in our research.

3.3. The path of photomicrography towards artistic recognition: contributions from *The Photographic Journal*

16 When we refer to "recognition" two major questions must be answered beforehand. Firstly, "Recognition of what"? Secondly, "Recognition by whom"? We consider that the latter is, to some degree, difficult to answer in this case mostly due to the wide range of possible answers. By conveying both news and opinions generally authored by professional and amateur enthusiasts of photomicrography, *The Photographic Journal*, as key source of information, allowed for an analysis on how photomicrography was regarded *amongst peers*.

17 This a complex matter and one may not state that photomicrography was clearly accepted as art immediately after its appearance.[18] In fact, by the second half of the nineteenth century photomicrography *per se* was still, to some extent, disregarded. In 1864, referring to the pioneers of photomicrography, Richard L. Maddox[19] wrote in *The Photographic Journal*:

> Without in any way detracting from their most valuable efforts to lift this art to some acknowledged rank in science, I fear we shall find their appeals did not

> obtain, from either microscopists or photographers generally, the favour their talent and energy in clearing away obstacles, coupled with the beauty of their achievements, might have been expected to command. Where was the fault? There must have been something serious against this branch [photomicrography]; for we can note how feebly it has kept pace with the vast progress of photography in all other kind of illustration. (Maddox 1864, 151)

18 Despite his apprehension concerning the then-current state of photomicrography, Maddox was confident that it was close to attaining a more rightful place in the "present thin ranks [that] may be swelled by those who have mastered the photographic side, and are willing to conquer the microscopic portion" (1864, 151).

19 In the late 1800s photomicrography was said to be a growing practice among scientists.[20] Technical improvements such as those regarding the "rendering of various colours" and innovations in microscope and camera lenses contributed much to this success (Gunther 1890, 75; Pringle 1891, 71). Also, the use of photomicrographs as lantern slides illustrating scientific lectures is well recorded as well as are their contribution to a wide range of sciences from medical research to botany, zoology, entomology, geology, chemistry or physics.[21] The aforementioned accounts demonstrate that photomicrography was clearly acknowledged within the scientific community by the end of the nineteenth century. However, a question still remains: were photomicrographs, such as the wings of a May-fly, shown in figure 2, appreciated and even created based on their aesthetic qualities?

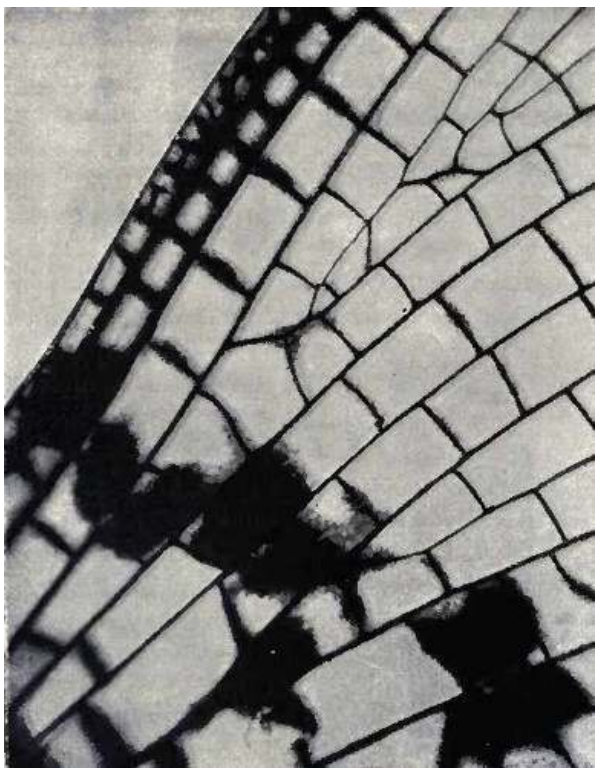


Fig. 2 – Photomicrograph showing a portion of the wing of a May-fly. C. 1904. John Ward. From Minute marvels of nature : being some relevations of the microscope exhibited by photo-micrographs taken by the author.

3.3.1 The aesthetic appeal of a "Lilliputian" world: the emergence and development of pictorial photomicrography

20 In the early twentieth century scientific applications of photomicrography were much more highly regarded than its potential artistic value. Nevertheless, microscopic natural compositions and patterns were definitely considered *beautiful*[22] by many (including artists and scientists). Patterns and shapes presented in photomicrographs suggested an abstract and subjective world, which was often extremely pleasing to the eye while challenging the observer's attention to pattern and detail. An artistic intention was also emerging in the production of photomicrographs. What began by being an unfamiliar and unreachable visual vocabulary, when given enough time would touch the imagination and creativity of the artistically aware photographer: In 1903, Albert Norman (1903, 64) wrote:

> I hope that you will accept a few notes which are based on my experience of several years of photomicrography, combined with upwards of twenty years of practical photography. (...) In photomicrography we have a great branch of our science which is of immense value to scientific men for obtaining not only accurate records of microscopical research for illustrating text-books, lectures and journals, but also of absorbing interest to many in portraying the varied beautiful minute vegetable and animal forms.

21 Faced with a world envisioned with infinite possibilities, *pictorial photography* finally ventured into the invisible. The first allusion to the concept of "pictorial" as associated with photomicrography in *The Photographic Journal* relates to an exhibit entitled *The Photomicrography of Metals: A House Exhibition* presented in 1903. The exhibit was comprised of photomicrographs by Charles Grindrod. In the opening address he[23] stated:

> I am only a pictorial photographer, a lover of and humble follower after beauty, and it would be hard to find any person more ignorant of the science of photography than myself. If anybody asked me awkward questions about my lenses, or the chemicals I use, I should have to put them off with (...) a very full aperture, of my ignorance." (...) Whether we are true artists, or mere clutchers [sic] at the fringed robe of art, at least our ambition is a worthy one, at least our shaft is aimed at the throne of beauty, and by aiming high we may perhaps strike the feet of the goddess and the goddess of beauty has golden feet as well as golden head; there is no clay in her, every part of her is precious metal.[24] (Grindrod 1903, 152-158)

22 From this point onward, pictorial photomicrography appeared more regularly, although not copiously within *The Photographic Journal*.[25]

23 Nonetheless, a division seemed to persist. As if referring to two separate territories with a shared borderline, Thomas Scott (1917, 122) describes a "dividing gulf" between pictorial and scientific photomicrography:

> (...) there does not appear, on the surface, much in common between the "ultra" scientist and the "infra" artist; and the photomicrographist [sic] is apt to hold himself aloof from the High Art aspirant to soulful Sonatas. (...) Generally speaking, of course, there are exceptions, the qualifications of profound science *are* and advanced pictorialism *are not* combined in one person. Outlook and aim give them separate entities, and in that outlook and aim is the alleged great "gulf" or difference. The scientific worker has perhaps more definite aims, and certainly a definite technical standard, but the pictorial worker's outlook is more or less abstract and idealistic, and he does not lay claim to any definite and tangible standard as a measure of success.

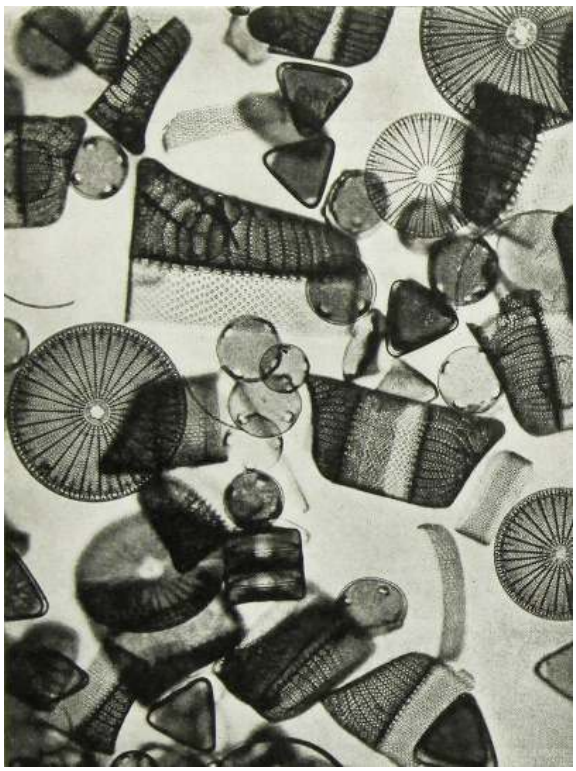


Fig. 3 – DEEP SEA MUD, C. 1933, AUGUST KREYENKAMP

24 In pictorial photomicrographs, composition, light and colour were combined with the intrinsic aesthetic qualities of the microscopic dimension. Without abandoning the scientific and technical quality, the *artist-scientist,* rearranged, coloured, highlighted and interpreted the infinitely small as to capture the hidden beauty of the vegetable, mineral and animal realms with a camera. According to Jelley (1932), these would have to fulfil a series of visual and aesthetic criteria to be considered pictorial images and differentiated from scientific images.[26] Diatoms, plant stems and leafs, insect wings and crystals are at the top of the subjects in pictorial micrography. Figure 3 represents a photomicrograph by August Kreyenkamp entitled *Deep Sea Mud*. It represents a set of Diatoms "in random arrangement" and was considered "remarkable for its depth of focus and crisp definition". It was part of a set of pictorial photomicrographs which received wide praise:

> His «Wood Chips» (680) is a splendid illustration of the beauty to be found in a seemingly common-place object. «Wasp's head» (681) is also an effective study which could easily serve as a design for up-to-date feminine hat. (...) «Butterfly wing» (683) is yet another illustration of the possibilities of decorative photomicrography in the hands of an artist. (Jelley 1932, 338)

25 The author of these comments is presented as "E. E. Jelley", most probably the scientist Edwin E. Jelley. His observations towards August Kreyenkamp's photomicrographs reflect not only acceptance but admiration for the artistic side of photomicrography, with the added significance of being uttered by a scientist. In short, in the 1930s, the artistic distinction between pictorial and scientific photomicrography was clear. By then artistic merit, when existent, of pictorial photomicrographers was generally accepted and even encouraged amongst peers. Photomicrography was then acknowledged as being art as well as science.

26 This presented new challenges for those who wished to explore the artistic side of photomicrography, starting with the demanding task of keeping its artistic "status" while adapting to the advances both in technology and art.[27] Allusions to the progresses of photomicrography, some containing references to its artistic variant, extended throughout the decades of 1940 and 1950.[28] Articles were then illustrated in colour, adding yet another element to the visual universe of photomicrography. But would that "dividing gulf" mentioned by Thomas Scott narrow and bring both sides closer? In other words, could art and science share a common ground in photomicrography?

27 We find the answer might be found in the essence of what Paul Strand wrote in 1923 about photography:

> Look at all these things. Get at their meaning to you; assimilate what you can, and get rid of the rest. Above all, look at the things around you, the immediate world around you. If you are alive, it will mean something to you, and if you care enough about photography, and if you know how to use it, you will want to photograph that meaning. (Srand 1923, 615)

28 In 1963, photographer Douglas Lawson wrote and illustrated an article for *The Photographic Journal* entitled "The Aesthetic and Pictorial Applications of Photomicrography" (1963).

29 It is a profound statement of his view of artistic photomicrography. It also reveals a sort of symbiotic maturity of photomicrography regarding the link between art and science. As we read through the whole composition of text, drawings and micrographs, it resonates with Paul Strand's message on finding and photographing the meaning of the world around us:

> On the one hand, with the help of the telescope we raise our eyes to the distant stars and behold something of their fascination, and on the other hand, with the help of the microscope, our eyes see the wonder and beauty which is offered by nature. Around our feet, in every blade of grass and in every tree, not to mention insect life, there are limitless details of creation. (...)
> When mentioned within the hearing of some pictorialists they immediately think it is only for the scientifically minded, or the record worker. Nevertheless, the so-called record photograph can be made to look quite attractive. Some of you may remember Mr. H. A. Murch, one of our great pictorial photographers, once saying, "I do understand the desire to apply pictorial ideas in record work, which is a very different objective, and we ought to welcome such an application when it can be done without losing anything of the essential factual value of the record". Photomicrography offers expression not in what the painter has already done but in what the painter cannot do. (Lawson 1963, 1)

30 We find this text celebrates freedom of creative expression by means of photomicrography. We also conceive that this "art-science" was finally embracing its individual identity as a distinct medium for reproducing the deepest layers of the world. Furthermore, Lawson presents us with a micrographic universe where art and science *can* and *do* coexist, within a territory governed by mutual respect for one and the other, that even though not always easy is definitely proven possible.

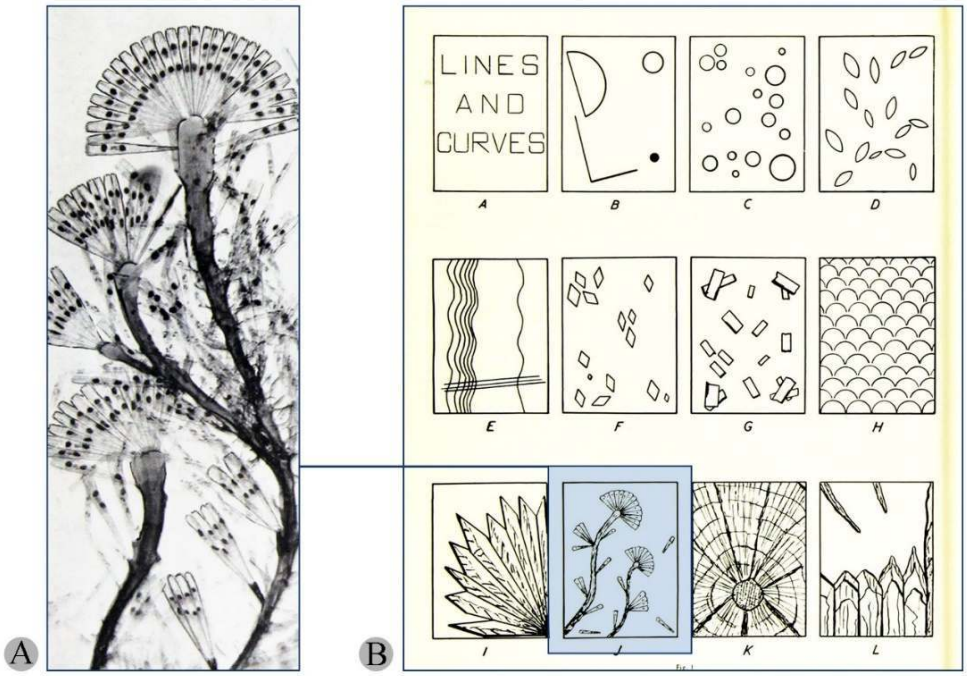


Fig. 4 – Lawson, D. F., 1963. Illustrations of Journal article. *The Photographic Journal*. A. Photomicrograph of Licmophora Flabellata (x600). B. Illustrations based on photomicrographs

31 The images contained in figure 4 are authored by Douglas Lawson. The drawings unveil form and line as the micrograph highlights transparencies and detail. Here, expression and interpretation meet impression and objectivity. Whether they are aesthetically appealing is a subjective matter. Whether they convey scientific knowledge depends on their specific characteristics and the perspective from which they are looked at. We trust the answers to these questions will benefit from the increase of joint scientific and artistic endeavours.

3.4. Contemporary artistic photomicrography

32 Cooperation between art and science is revealing itself to be quite successful, if not so much in quantity, certainly in quality. When it comes to photomicrography, it has benefited much from competitions and awards, such as "Polaroid's Instant micro-contest" (1991, 281), an annual competition that was launched in 1982 and ran throughout the 1990s or the Novartis/Daily Telegraph Visions of Science Competition launched in the year 2000, which included a great number of photomicrographs. *The Photographic Journal* gives notice of this competition in an article entitled "Lyrical Visions of Science" (2001). The article demonstrates the eagerness in which the visual universe of science is received in photographic exhibitions.

33 Today, the most popular international photomicrography competition is Nikon's Small World Photomicrography Competition. It dates back to 1975 and goes on its 40th edition. The submitted images are judged for "their scientific and artistic merits"[29] (Thompson 2013) and represent a wide range of magnified visual subjects. An exhibit comprised of these images would certainly be something to be remembered. Some of these photomicrographs present allegorical and metaphorical titles, an interesting aspect that

comes to reinforce the relation of subjectiveness and objectiveness underlying the philosophy of this competition. It is also interesting to observe how the images evolved since its first edition, but simultaneously, apart from the quality and digital treatment, these differences are, in many cases, almost imperceptible (2014).[30] The cost of photomicrography has not been addressed here but it is an extremely relevant topic. It is still a very specialized practice. The demand for costly technologic equipment and well-equipped laboratories certainly poses an obstacle to many artists who consider venturing into photomicrography in contrast with the scientific community who can have access to sophisticated imaging technology more easily, mostly in research institutions. This may help explain why most of Nikon's Small World Photomicrography Competition images are attributed to scientists. As they gain popularity, awards and competitions are playing a very relevant role in enhancing the public knowledge of photomicrography. With the aid of digital media, such projects now reach a much wider public thus extending their contribution to the overall knowledge and appreciation of joint artistic and scientific practices.

34 A similar phenomenon is happening with collaborative or individual projects that tend to bring together art and science. In 2001, the above-mentioned article about the Novartis/ Daily Telegraph Visions of Science Competition of 2001 (2001, 479) encouraged this union, specifically referring to photomicrography. It makes an intrinsic distinction between a "scientific vision seeking for clues that may lead to cures for fatal cancers and other disease" and a "purely visual nature", as to say an artistic facet. However, it also expresses reverence towards the "compelling beauty" of the microscopic world, and considers the winning pictures "superb, often combining aesthetic beauty with their scientific content"; and further states the competition "highlighted that communication through imagery plays an essential part in scientific progress". Although short in content, this text conveys an important message, which restates the insightful words of Douglas Lawson in 1963: a union between science and art *is* possible. Moreover, it reinforces the idea that information and expression, knowledge and emotion may not only coexist but also complement one another in images of science.

35 In contemporary times, names such as the researcher Stefan Eberhard, the biochemist Manfried Friedrich or the artist and Professor Rob Kesseler are some of the protagonists of this story. Whether on a personal level or as part of interdisciplinary cooperation, they fuse the profundity of art with the greatness of science. Stefan Eberhard's shows us, through incredible bright colours, that "a microscopist with an artistic hunger can use this technique [photomicrography] as a fantastic «Art» tool. Abstract images with intriguing patterns, bold colours and a strong aesthetic appeal can be obtained by viewing microscopic crystals under crossed-polarized light" (Eberhard 2008, 32); while Manfred Friedrich, relies solely on his aesthetic perception to create minute images under polarized light. Friedrich's photomicrographs are refrained from any preconceived scientific purpose and do not correspond to any sort of artistic compositional order either (Friedrich 2003, 204).

36 Rob Kesseler's passion for the natural world led him to create a vast visual universe that traverses his career both as an artist and a Professor. At present, he is dedicated to photomicrography, which he treats with tints of subtle colour to create inspiring micrographs from botanical specimens.

> His choice of colours is a personal one and may relate to the original plant or be used to reveal functional characteristics of the specimen. It is used intuitively to

> create mesmerizing images that lie somewhere between science and symbolism, sensual markers inviting further contact with unseen miracles of the natural world. (Stuppy et al. 2009, 9)

37 In 2011, Kesseler was a fellow at Gulbenkian Science Institute (IGC) in Portugal. He worked alongside scientists from IGC and focused his attention on Portuguese flora. The result was an exquisite set of cellular patterned prints derived from stained glasses of plant stems, which were applied to porcelain plates for Vista Alegre Atlantis (Kesseler 2011, Gerschenfeld 2011). It may seem surprising and unexpected to see images of science on a domestic plate, but there is a long tradition of scientific discoveries influencing designs within the domain of the domestic artefact. Figure 5 shows a set of plates in the way they were disposed for the exhibit.

Fig. 5 – Plates fron "Jardim Porcelânico" for Vista Alegre Atlantis, 2011
© Courtesy of Rob Kesseler

38 Projects such as this one are an important contribution to promote the dialogue between art and science. The microscope is the only "path" one has into the "invisible" side of Nature. We have no references through unaided vision to compare it to, as we do with a photograph or an observation drawing. Therefore, trust becomes the "measure" of our sight in regard to the microscopic dimension. In other words, through photomicrographs, scientists and artists have in their hands the power to be the mediators of the microscopic world. The way they perform this task and make that visual universe known to the public is decisive for our own perception as observers. Having the capacity to influence the way nature is comprehended and appreciate is as much a challenge as it is a responsibly. We argue that there is a common ground for science and art in this matter. There is still much to accomplish in this area but there is an optimistic experience to learn from regarding photomicrography.

4. Conclusions

39 With this paper, we are not presenting the artistic acknowledgement of photomicrography as an undisputed issue. As in other artistic fields, especially in contemporary art, absolute consensus is not always easy to reach, nor is it, in our view, possible, given the multiple perspectives each of us has on life, the world, science or art. Journeying through the various phases of photomicrography, from the nineteenth century to the present time, provided a broad sense of perspective and allowed for a comprehensive approach on the process of its artistic recognition. For a long period of time photomicrography appeared suspended in a conceptual *limbo* between artistic endeavour and scientific purpose. In its earlier years, pictorial and scientific, knowledge and beauty, however, were part of one unique visual universe. We have shown that it was not until the twentieth century that photomicrography was seen unpretentiously as a form of artistic expression, as science and art were looked upon as two complementing and well accepted sides of the same visual cosmos. Contemporary photomicrography is teaching a valuable lesson about the "added value" of this collaboration between art and science. Scientists and artists are working together to create expressive and aesthetically appealing images, portraying the invisible side of the natural world and making it known to the public with the potential of making a difference on how we perceive and appreciate nature. This study aimed to convey the message that the value of nature does not reside exclusively in its purest scientific significance nor does it rest merely on a contemplative pictorial worth. If scientists and artists concentrate their efforts in meeting its complexity with an unbiased mind, they will surely be set to venture into much more prodigious achievements through the unification of scientific understanding with aesthetic interpretation. This is a subject that would benefit from further study.

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NOTES

1. The journal's denomination changed several times over the years. It was originally known as *The Journal of the Photographic Society of London: Containing the Transactions of the Society and a General Record of Photographic Art and Science*.

2. Other publications may be explored with a similar approach, for instance *The British Journal of Photography* (1854-). We consider periodicals such as these are extremely relevant sources on this topic of research. They have the particularity of comprising a wide range of updated news on a specific subject over time, in this case the wide-range of photography, as well as opinions and generally substantiated points of view, all in the same source.

3. The use of Optical Character Recognition (OCR) in all digitized volumes of *The Photographic Journal* (available online) was particularly helpful, as it allowed for an effective preliminary search in a short period of time.

4. By "indirectly" we mean references that although not mentioning the term art itself, as associated with photomicrography, allude to the aesthetic qualities of photomicrographs.

5. By "artists-scientists" or "scientists-artists" we mean artists that cultivate a link to science in their work and scientists that also artistically explore scientific images. In short, multifaceted artists and scientists that foster the union between art and science.

6. Bozal (2000), Gamwell (2002), Sicard (2006), Bergdoll (2007), Dagnino (2008), Blakeney (2009) have addressed this subject.

7. In this period Darwin set sail on the HMS Beagle (1831-1836) to discover the mechanisms of natural life (Wyhe 2002; Gamwell 2002, 29).

8. The link between art and science is an ancient one and certainly gained from the fact that, in the 1800s science was more accessible to the public, including artists.

9. Microscopic structures began to be observed with a clarity and definition never seen before (Gamwell 2002, 45). In the core of this scientific and technological progress were the experiments that culminated in the production of a fully functional achromatic microscope, which allowed for a clearer and more focused look into the microscopic scale (Carpenter 1901, 149).

10. Ernst Haeckel, German naturalist, botanist and zoologist. His work *Kunstformen der Natur* (1904) had undeniable influence on late nineteenth century aesthetics (Kulper 2012, 3; Gamwell 2002, 29; Walgate 2003, 9).

11. Particularly in *Art Nouveau*.

12. Given the varied artists who expressed an interest in the link between art and science, and the specific topic of this article, we opted to give solely these two examples whilst focusing on Klimt directs our attention to the subject of photomicrography.

13. Martin-Duncan (1937, 37) provided a clear definition of a photomicrograph: "a photograph of the magnified image of a small or very minute object obtained by the combined use of a camera and a microscope, or by the use of a camera to which a microscope objective has been attached".

14. Probably lantern slides, which were a common medium used by lecturers at the time (Martin-Duncan 1911; Smith 1911; Smith 1887).

15. Various authors address this matter, e.g. Armstrong (2004); Benjamin et al. (2008); Frizot (1998), Martin-Duncan (1911), Horsfield (2004), Rosenblum (1997).

16. This represented significant "limitations" for the photographer, i.e. meaning that to create a picture the photographer was dependent upon a machine. In addition, the camera was only controllable to some extent. This was especially relevant for composition, point of view and the final touches on the picture. Any instrument used to create art poses a certain level of "limitation" not necessarily positive or negative, but a restriction nonetheless. However, the photographic camera was also a mechanical novelty that, along with the complexity of the photographic process, challenged the creative autonomy of the photographer. Despite the enthusiastic side of this novelty, we gather that these factors would stimulate an initial resistance to photography, especially from those poorly acquainted with mechanical instruments and science.

17. In older texts, the term may appear hyphenized (photo-micrography) or as "micrography". To obtain a complete listing we followed this criterion. Nonetheless, every record was confirmed as to its relevance concerning photomicrography.

18. This remains a debated topic in contemporaneity.

19. Richard Leach Maddox (1816-1902) was a British scientist and photographer and one of the most important contributors to photomicrography (Stevenson 2011).

20. Demonstrated in articles such as "On Photo-micrography and its Value in Biological Research", by Edgar Crookshank (1887) or "Photomicrography", by A. Pringle (1891). In the latter, the author states that the "subject of photo-micrography (...) is very fast gaining ground in this and other countries, and which is now playing an exceedingly important part in connection with certain branches of general science" (Pringle 1891, 71).

21. These contributions are well documented in various papers published in specialized periodicals, e.g. *The Photographic Journal*, *The Journal of British Photography*, and books: Seiler

(1881), Malley (1885), Mercer (1886), Moitessier (1866), Carpenter (1901), Walmsley (1902), Kerr (1905), Bagshaw (1909), Hind (1913).

22. With all due care regarding the subjective nature and significance of *beauty*, several articles within *The Photographic Journal* allude to the *beautiful qualities of photomicrographs*, e.g. Maddox (1864), Smith (1887), Stock (1887), Grindrod (1903), Norman (1903) or Grindrod (1903, 154), who considered that "beauty has a range as wide as the realm of nature and the mind of man, and to try to limit it is like the Chinese process of binding the feet."

23. Grindrod was an author, a photographer and a member of the Royal Photographic Society.

24. We are unable to transcribe the entire text, but an attentive reading of this lecture is extremely insightful regarding the artistic recognition of photography and photomicrography in the early 1900s. Among other aspects, it comprises a series of comments on the artistic nature of photography, including an interesting, and quite revealing account of his attendance at the Jubilee dinner of the Royal Photographic Society where, to his surprise "Scarce a word was uttered the whole evening by the eminent speakers present on the art side of photography; all was about the progress of the scientific side" (153).

25. E.g. Martin-Duncan (1911, 64).

26. "(...) pictorial micrographs should have well-balanced composition and should exhibit some striking or beautiful aspect of the microscopical object, but they should not unduly reveal the limitations of microscopy, such as curvature of field, lack of definition at high magnifications, and shallowness of depth of focus" (Jelley 1934, 492-493).

27. A pressing matter in contemporaneity.

28. E.g. Howard (1941).

29. This competition is still viewed with some degree of suspicion within the art world, mostly regarding the specific criteria to assess scientific and artistic merits; and the artistic credentials of the judges.

30. In 2011 a motion picture competition was held and maintained for three years in a row. The 2013 Video Competition winner was the Portuguese Gabriel G. Martins from the Gulbenkian Science Institute (IGC) (Gannon 2013).

ABSTRACTS

Photomicrography has been subject of several studies over the years, mostly on a technical perspective. The artistic side of photomicrography is a promising topic of study, which has gathered important contributions for the connection between art and science. In contemporary times it is generally regarded as a form of artistic expression, alongside its role in science. Nonetheless, this subject would benefit from a comprehensive approach so as to understand the process of artistic recognition of photomicrography as part of an increasing dialogue and mutual acceptance and respect between art and science. The present study aims to clarify how photomicrography came to be accepted and fully acknowledged as art from past to present. Moreover, it aims to shed light into collaborative contemporary practices where art and science meet to stimulate a greater appreciation of the natural world. Documental analysis and interpretation was conducted, namely of written texts and images comprised in *The Photographic Journal* of the Royal Photographic Society between 1853 and 2013. The data retrieved and analysed was complemented with information regarding contemporary artistic photomicrography. Research has shown that, despite persistent resistance, in the early years of

the twentieth century artistic photomicrography was accepted and subsequently acknowledged and encouraged. Photomicrography is currently on a growing path, to a great extent due to contemporary practices where its scientific and artistic potential are brought together to promote the experience, understanding and appreciation of the natural world.

A fotomicrografia tem sido objeto de vários estudos ao longo dos anos, sobretudo do ponto de vista da técnica. O lado artístico de fotomicrografia é um tópico de estudo promissor que vem reunindo importantes contribuições para a relação entre arte e ciência. Na contemporaneidade, esta é largamente considerada uma forma de expressão artística, ao lado do papel que desempenha na ciência. No entanto, este tema poderá ainda beneficiar de uma abordagem abrangente que possibilite compreender o processo de reconhecimento artístico da fotomicrografia como parte de um crescente diálogo, aceitação mútua e respeito entre arte e ciência. O presente estudo tem como objetivo clarificar a forma como a fotomicrografia veio a ser aceite e amplamente reconhecida como arte, do passado ao presente. Visa, ainda, lançar luz sobre práticas colaborativas contemporâneas, nas quais arte e ciência se reúnem para estimular uma maior valorização do mundo natural. Com essa finalidade, foi realizado um trabalho de análise e interpretação documentais centrado em textos escritos e imagens do periódico britânico *The Photographic Journal* da Royal Photographic Society, entre 1853 e 2013. Os dados recolhidos e analisados foram complementados com informação relativa à fotomicrografia artística contemporânea. A investigação demonstrou que, apesar das reservas persistentes, nos primeiros anos do século XX, a fotomicrografia artística foi aceite e posteriormente reconhecida e incentivada. Atualmente, a fotomicrografia está em ascensão. Isto deve-se, em grande medida, a práticas contemporâneas que têm vindo a conjugar o seu potencial científico e artístico para promover a experiência, a compreensão e a valorização do mundo natural.

INDEX

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